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KATHOLIEKE UNIVERSITEIT TE LEEUVEN

Departement Geografie-Geologie

Laboratorium voor experimentele geomorfologie en tropische streken

REPORTS on

LAKE TCHAD AND ZAIRE BASINS AND SURROUNDING AREAS

Regional-geographic and Geomorphic Analyses using

ERTS-Satellite Imagery (NASA User I.D. F085)

R E P O R T N° 4

ERTS-1 Strip: INONGO-INGENDE-GENENA-BOSOBOLO

J. Sterckx

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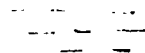
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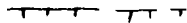
LEGEND

Clouds .



physical features

- scarp



- erosion



- river pattern - braided



- meandering



- lake



- forest



- savanna grassland



- marsh



human features

- settlements, roads, crop and fallow land



- burnt areas



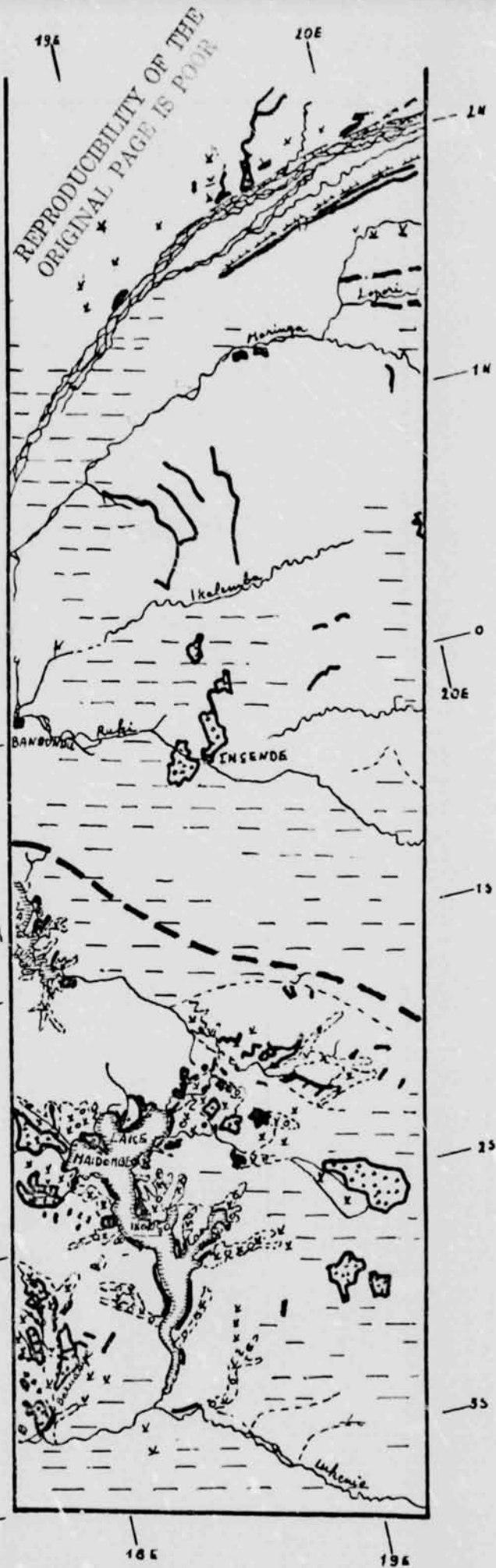
regional-geographic division

- limit of subregions



- limit of regions





REPRODUCIBILITY OF THE
ORIGINAL PAGE IS POOR

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Report N° 4

ERTS-1 strip: INONGO-INGENDE-GEMENA-BOSOBLO (Zaire)

ID 1096-08250, -08253, -08255, -08262, -08264, -08271

by Jozef STERCKX

INTRODUCTION

This ERTS-1 strip covers an area which extends from the Ubangi in the north to the Kasai in the south. Its southern part coincides with the northern part of a strip taken eighteen days before, which extends over the Kwango plateau to the Zaire-Angola frontier. Thus, the two strips cover the area of Lake Maidombe (former Lake Leopold II) and the Lukenie and Kasai rivers. The southern strip is better for the Kasai-Lukenie area, while the northern is more suitable for the analysis of the Lake Maidombe area. So we will take the Lukenie as southern limit for analyzing the northern strip. The geographic coordinates of the area without the Kasai-Lukenie divide can be approximately stated as follows:

NE: 5°00 N/21°00 E

NW 5°20 N/19°30 E

SE: 3°20 S/19°10 E

SW 3°00 S/17°40 E

This gives an area of about 195.000 km²

PART I PROCEDURE OF ANALYSIS AND INTERPRETATION KEYS

A first approach consisted in^a direct analysis of contactprints on a 1/3.369.000 scale, only using a magnifier, in order to recognize the most striking differences in tones and to suggest hypotheses about the corresponding features in the area.

In a second step the positive transparencies (in particular bands 5 and 7) were projected on a 1/1.000.000 scale, and sketched; these sketches were grouped later to form a continuous strip. The analysis of the transparencies permits the following statements:

- (1) Human facts, such as roads and settlements strongly contrast with vegetation and therefore they appear most clearly on the images of band 5, which belongs to the spectral zone characterized by the increasing absorption of radiations by chlorophyll. So on band 5 objects with chlorophyll are clearly distinct from objects without (Higham A.D. 1973). Of course the recognition of these human facts on ERTS-images depends on the real dimensions of these facts and on the resolution capability of the images; these two reasons often hinder recognition.
- (2) The absorption capacity of chlorophyll decreases all at once about 0,7µ and chlorophyll becomes highly reflectant for longer wavelengths. This limit of 0,7 µ oscillates a little in function of chlorophyll content: a very high chlorophyll content pushes up the absorption limit to the longer wavelengths (Higham A.D. 1973). This statement is very important in distinguishing cultivated areas from forested areas: whereas on band 5 (0,6-0,7 µ) both absorb the radiations, on bands 6 and 7 cultivated areas reflect much more than forested areas (it cannot be attributed to soil reflectance, since the reflectance begins suddenly at about 0,7 µ, while soil reflectance appears to increase monotonically with the wavelength over the spectral range 0,5 µ to beyond 2 µ (Higham A.D. 1973).

Finally a multispectral projection of bands 4, 5 and 7 was realized in false color using a red filter for band 7, a green for band 5 and a blue for band 4. This false color enhancement of signatures gives complementary information to the analysis of black and white images: namely

- differences in red tones correspond to notable differences in vegetation cover based on its differences in chlorophyll content:

dark red : tropical moist forest, edaphic forest, forest galleries
 red : savanna woodland
 bright red: cultivated areas
 = homogeneous red: plantations
 = with dark dots: crop and fallow land
 yellowish red: dry savanna and steppe

- the Kasai river appears black with a greenish shine due to the water being reddish coloured by sediment load.

A great inconvenience for analyzing and interpreting the images was the high cloud cover present in many parts of the strip, in particular southeast of Lake Maidombe and in the basin of the Ruki, affluent of the Zaire. Elsewhere cloud cover is slight to moderate, while in the neighbourhood of the Ubangi there is more haze. However clouds are chiefly cirrostratus and cirrocumulus and are somewhat transparent; this property permits to recognize some features which strongly contrast with the environment, such as black toned rivers and light toned cultivated areas, although in these cases the limits lack sharpness.

PART II DISCUSSION OF THE IMAGES

II.1. Particular signatures on the images

II.1.1. The area of the Boruampe-Montaba (ID 1096-08271)

On band 7 we observe whitish spots on a relatively dark background, they are separated by a few light gray toned bands outlined by almost black narrow and discontinuous lines. On band 6 the whitish spots are as gray as the bands, while on band 5 no differences in tone can be observed and the whole area is black. The light gray toned bands are interpreted as alluvial plains, although river beds can not be recognized; the alluvial plains are probably covered with a marshy vegetation and bordered by small rows of bushes. We believe the whitish spots are crop and fallow land.

II.1.2. An area NW of Lake Maidombe (ID 1096-08264) and a few areas south of the Ubangi and in the Lua basin (ID 1096-08250, and -08253) are characterized on band 7 by numerous black spots on a dark gray background. These spots are less distinct from background on band 6 and more clear than background on band 5 images. The spots are probably areas burnt before cultivating, as we believe we have recognized crop land in the neighbourhood.

II.1.3. On band 7 of the images ID 1096-08264 and -08271 relatively short bands, more gray than the surroundings, show a general pattern of vallies which debouch into Lake Maidombe. They are clearly outlined on band 7 images, but they vanish on band 6 and are no longer recognizable on band 5 images. These signatures are considered as real shallow vallies covered by an edaphic forest; the latter is characterized by a higher chlorophyll content than the surrounding tropical forest because of the greater humidity of alluvial plains. The vallies drain the surrounding areas into Lake Maidombe.

II.2. A general discussion of the strip

II.2.1. Relief and hydrography.

Three areas can be distinguished: south, central and north:

The southern area is characterized by Lake Maidombe and surroundings, including Lake Tumba. The elongated form and nearly constant wideness of Lake Maidombe have been interpreted by L.Cahen (1954) as indications of an inundated valley due to a local slight subsidence. The ERTS images do not show signatures of this subsidence other than can be seen on maps. The narrowing of the south end of the Lake and the splitting up into three lobes at its north end may suggest a subsidence with a gentle slope to the north. On the other side the short vallies of affluents are always directed to the south giving the whole drainage system a dendritic pattern. If there is a subsidence, a marshy area can be expected at least on the northern end of the Lake; indeed the ERTS images show a vast marshy area with numerous pools on the northeast of Lake Maidombe. This marshy area is also drained by a affluents of Lake Tumba. On maps the drainage systems of Lake Tumba and Maidombe are drawn as clearly separated systems. On ERTS images(1096-08264) the two systems appear joined in the marshy area, northeast of Lake Maidombe. This difference between map and ERTS-images must be resolved by ground truth. Most banks of Lake Maidombe show a relatively regular pattern. On band 5 these banks are emphasized by small very light toned lines; in false color projection the lines are almost white so that we believe they correspond to features of human presence and not to a marshy vegetation bordering the Lake. On maps villages are situated at regular distances on the lake banks, so it is very likely that the lines represent villages elongated along the Lake.

The central part focuses on the Zaïre, which is a braided river with numerous islands and sandbanks. Remarkable is the local splitting up of the stream into two groups of branches enclosing a very large island. The Zaïre valley cannot be outlined on difference of gray tone only, but these differences are emphasized by a light toned line separating them. The stream has constructed a large alluvial plain. South of the Zaïre important affluents can be recognized but it is only in the area of the Maringa-Lopori that cloud cover does not hinder more detailed observation. The Maringa is a meandering river with braided characteristics. Upstream of the Maringa-Lopori confluence, the valley of the Lopori also appears delimited by a light toned line on both sides. On the Lopori-Zaïre divide there is perhaps a small marshy area. North of the Zaïre a large marshy area is recognizable by its homogeneous dark gray tone on band 7; it widens from the Mongala in the east to the Giri in the west, and penetrates upstream into the vallies. The Mongala is a small meandering river. The Giri appears to be an inundated valley with a strong marshy character. Here also the marshy area is clearly limited by a zone characterized by numerous light toned areas. The Giri absorbs radiations in band 7 (0,8-1,1 μ) and reflects them in bands 5 (0,6-0,7 μ) while band 6 (0,7-0,8 μ) takes a transitional position. We believe this differentraction is due to suspended sediments which increase the reflection properties of superficial waters and decrease their absorption capacities (Higham 1973) ; for that reason on band 7 the Giri is less black than the Zaïre.

The northern area encloses the Zaïre-Ubangi divide and is chiefly drained by the Lua system. It appears to be an almost flattening area shallow incised by the Lua and its affluents. The Ubangi forms the northern limit of the area; it is a braided river, which also describes a few angular bends. This angular configuration suggests the presence of some structural influence, but another indications could not be detected on the images.

II.2.2. Vegetation

In general dark tones predominate on all bands, which means that the area is forested. In the northern part of the strip the tone of images is less homogeneous than elsewhere, it has a mosaic appearance. Thus we have two distinct areas. The very homogeneous area (south and central parts) must be a dense, evergreen forest or tropical moist forest. This forest is interrupted by small darker areas along rivers, corresponding to the edaphic forest. The northern area with a mosaic character must correspond with a clear forest or to a bush savanna; in some parts of the images dark lines of forest galleries are visible. The images do not allow us to state a clear limit between the savanna area and the moist tropical forest; it is perhaps to be found on the Zaïre-Ubangi divide about the Lua-Vindu, north of Gemena. This situation appears to correspond very well to the data found in the literature (J. Peeters). The author gives the following succession from the Zaïre to the Ubangi: on both sides of the Zaïre the edaphic forest, then the tropical moist forest and finally a bush savanna with important forest galleries. It is not a continuous savanna, because it is interrupted by islands of dense forest. In this area (NW of the Zaïre republic) the savanna touches the tropical moist forest without the normal transitional semideciduous forest. The forest islands are generally constituted by a moist, semi-deciduous, subequatorial forest. So we have to conclude the semi-deciduous forest has been destroyed and the bush savanna indicates a degradation of vegetation.

II.2.3. Human presence signatures.

Features of human presence are settlements, roads and cultivated areas. The last give the clearest signatures on ERTS-images; settlements and roads are generally too small and can only be recognized where there is heavy contrast. The cultivated areas are recognizable by their light tones, but on different spectral bands in function of the basic vegetation (namely on band 7 in the area of tropical moist forest and on band 5 in the savanna).

In function of density of cultivated areas four regions can be considered:

- The Maidombe region. We have already noticed the more or less regular configuration of the Lake banks. On band 5 the latter are outlined by almost white lines, which probably represent villages elongated along the Lake. These villages do not appear to be accompanied by important cultivated areas. Cultivated areas are recognizable in the basin of the Barumpe-Montaba and about the northern end of the Lake. East of the Lake a few plantations can be recognized by their geometrical configuration. These are probably palm plantations.
- The Ruki-Zaïre region. Here cloud cover hinders observation and only features characterized by sharp contrast are visible. We recognized a few roads with cultivated areas and a few plantations - marked by their almost geometrical configuration - in the neighbourhood of Ingende. The Lopori and the Zaïre are accompanied by cultivated areas extending parallel with the rivers; probably they are situated on or just above the valley sides.
- The Zaïre-Giri-Mongala region. Immediately north of the Zaïre sparsely cultivated areas are visible in the large marshy area. The basin of the Upper Giri and the basins of the northern affluents of the Mongala, which enclose the settlements of Budjala and Gemena, are densely cultivated. On maps this region appears densely occupied. The cultivated areas avoid the vallies, as can be recognized on ERTS-images.
- The Lua-Ubangi region. Three areas can be recognized with cultivated and burnt areas. In the west a plantation area is recognizable by its geometric configuration. This region does not appear to be densely occupied and the two southern cultivated areas are prolongations of the former

region, while the third is situated on the Ubangi.

PART III PROPOSAL FOR A REGIONAL DIVISION

It is impossible to establish a regional division of the whole strip, because of the high cloud cover over the Ruki-Ikelembe area. So we can only consider partial divisions of the northern and southern areas of the strip as separate units.

The smallest land units recognizable are:

- important lake
- marshy area with pools and covered by a forest vegetation
- important alluvial plain covered with forest
- crop and fallow land in a forested area
- crop and fallow land in a savanna area
- plantation area
- plateau covered by the tropical forest
- plateau covered by a savanna

These smallest land units can be grouped into units of a higher order on the basis of coherency and resemblance; so we obtain the following subregions:

1. The Lake Maidombe subregion. It is constituted by Lakes Maidombe and Tumba and the more or less marshy surroundings covered by the tropical moist forest which is interrupted by scattered crop and fallow land, and plantations.
2. The Zaire subregion. This subregion encloses the Zaire valley, the Zaire-Maringa divide (south of the Zaire) and the vast marshy area north of the Zaire. The whole area is covered by the tropical moist forest, which is interrupted by sparse crop and fallow land characterized by linear patterns.
3. The Upper-Giri - Bonga(Melo) subregion. This extends east and west of the Budjala and Gemena settlements, and is a densely cultivated area. It is a savanna covered plateau with shallow incised vallies, recognizable by their forest galleries.
4. The Lua-Ubangi subregion. Here the plateau is incised by shallow vallies, but without forest galleries, and is covered by a savanna. Crop and fallow land is clearly grouped in a few places.

The latter two subregions can be grouped together in one region as they are characterized by a plateau relief, shallowly incised by vallies, and covered by a savanna which is interrupted by vast clusters of crop and fallow land. The same could be done for the first two but they are separated from each other by the heavily clouded zone on the Ruki.

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